# 7. Studies on the Anoplura and Mallophaga, being a Report upon a Collection from the Mammals and Birds in the Society's Gardens.—Part I., with a Preface. By Bruce F. Cummings, British Museum (Natural History) *.

[Received January 5, 1916: Read February 22, 1916.]

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Structure.

Development.

## *Preface.*

The following paper is the first part of a report upon the Anoplura and Mallophaga collected upon the Mammals and Birds that have died from time to time in the Society's Gardens, and kindly submitted to me for identification and study by the Zoological Society of London. On account of the opportunities for straggling on to other species of host afforded to ectoparasites on animals in a menagerie, the correct names of the hosts in some instances may be open to doubt, while the labour involved in the identification of the specimens is thereby much increased, particularly in two such groups as these, which in greater part remain in a state of considerable systematic confusion. In the present collection, however, I have come across very little evidence of straggling, and, in any case, such a contingency is amply compensated for by the fact that through the kind offices of the late Prosector, Dr. F. E. Beddard, F.R.S., and the Society's Pathologist, Professor H. G. Plimmer, F.R.S., much of the material has been fixed and carefully preserved in alcohol. It has thus been possible to add to the knowledge of many of the forms coming under review and to turn the report into something more than a dull census of names. The value of the systematist's routine work would be greatly enhanced if an endeavour were constantly made to add at least something, however small, to the pre-existing knowledge of the morphology of each species. The correct naming of an animal is the systematist's opportunity—too frequently neglected.

In entomology of late, those who observe the Heavens will have seen certain signs in the sky, one being the growing demand for spirit-specimens *pari passu* with the growing recognition that there is no group of insects in which a duplicate series of spirit-specimens is not essential for systematic study; while in many groups, such as those here considered and the Ephemeridæ, pinned or carded material is for the purposes of study almost worthless. Another portent is the obsolescence of the short, superficial Latin diagnosis in the description of new species—the persistent remains of the early influence of the schoolmen on systematic zoology. In some quarters the superficial diagnosis is already swept into limbo with the Sedan chair—both of them vehicles which could not possibly take us far, as traffic runs nowadays.

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As *précis* work the superficial diagnosis is admirable. A certain number of characters from a certain restricted area of an animal's anatomy (as a rule, the easily accessible external parts) are selected and then welded into a cast-iron paragraph as exact and inflexible as a lawyer's deed-poll. But in entomology, as in politics, the lawyer is a strong but undesirable element, and the only justification for the superficial diagnosis is that the descriptive writer sometimes may find it convenient as a summary to tag on to the end of a long description.

The systematist is primarily a morphologist whose task it is to discover the true phylogenetic relationships, at least between the small subdivisions such as genera and species. This is a responsible task, especially in entomology, requiring the dissection, careful morphological examination, and description of each species. Many characters which have to be dissected to be seen are already in use among systematic entomologists, *e. g.*, the male genitalia, the spermatheca, the mouth-parts, and endoskeleton. It is not suggested, of course, that internal or concealed characters are necessarily better than external ones. What are the best characters for systematic use is a question which has to be investigated and settled for each individual group of the Animal Kingdom. Quite recently Dr. P. Chalmers Mitchell wrote * :—"The more experience I gain of avian anatomy, the more I am convinced that systematists are well advised when they rely, at least with regard to the discrimination of species and genera, more upon those superficial characters that they can observe in the series of museum collections than on the uncertain indications afforded by the presence or absence of this or that muscle."

Yet, how many systematists have conscientiously gone through the anatomy of their group with a view to settling this fundamental question of the best combination of characters for the purposes of classification (for I imagine that single-character classification, such as Huxley's palate and Garrod's ambiens among birds is now discredited). The descriptive writer is an opportunist who, as a rule, seizes upon the most *convenient* characters that offer themselves. Certainly, it is in entomological opportunism that we must seek the cause of the present systematic disorder among the

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* P. Z. S. 1915, p. 413.

Anoplura and Mallophaga, for recent authors alone have agreed to treat these two groups from the morphological standpoint *.

Lest in the following essay it be urged, perhaps, that I have recked not my own rede, it must be explained that the amount of anatomical work which a systematist is able to accomplish on any one species is governed by the nature of the material—its quantity and quality. No attempt has been made to dissect species of which only one or two specimens were available, and in no case has it been possible to attempt the anatomy of the soft parts, as Part I. deals mainly with those specimens—in a poor state of preservation—which formed the nucleus of the collection handed over to me in the beginning from another worker who was prevented from carrying out the work.

## ANOPLURA.

### Genus Pediculus Linné.

Pediculus capitis De Geer (**1**).

Piaget (**2**, p. 626) described as a new species of *Pediculus* a form taken on *Ateles pentadactylus* Is. Geoff. from the collection of the Museum of Leiden. *P. consobrinus*, as it was named, is so close to *P. capitis* that one searches Piaget's text and figures in vain for reliable distinguishing characters, and Neumann (**3**, p. 440) concludes that *P. consobrinus* cannot be clearly separated from *P. capitis*. Without Piaget's types before me, it is impossible to be certain about this, but that *P. capitis* does on occasion in menageries pass from man to monkeys is shown by specimens captured in the Gardens on the Red-faced Spider Monkey (*Ateles paniscus* Linn., Family Cebidæ).

Pediculus affinis Mjöberg † (**4**, p. 169).

In large numbers on *Ateles paniscus* Linn. (Family Cebidæ) together with larvæ. In a lot distinct from the preceding.

Fahrenholz (**5**, p. 8) has described the larvæ of *Pediculus capitis*, with which the larvæ of *P. affinis* agree very closely, not only in the 3-segmented antenna, but in details of abdominal chætotaxy. Fahrenholz omits all reference to the larval chætotaxy of the head and thorax, and it is therefore worthy of remark that, while the head and thoracic chætotaxy (dorsal surface) of larvæ and adults are almost identical, the arrangement of the hairs on the ventral surface of these parts in the larvæ of *P. affinis* differs considerably, especially that of Stage I., from that of the adult in the same regions. On the dorsal surface the differences are negligible. But on the ventral surface of the head in Stage I. there are but two hairs (or bristles); in Stage II. there are four (two in front and two behind), and two minute hairs on each side in the preantennal area. The lower surface of the head of Stage III., as regards chætotaxy, closely resembles the adult, except that the small group of hairs behind each antenna contains fewer hairs than in the group of the adult. On the ventral surface of the thorax there are fewer of the minute scattered hairs.

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* The whole question of the methods of research employed by the systematic zoologist is discussed in an anonymous paper published in 'The American Naturalist' for May 1914 (p. 369) entitled "Taxonomy and Evolution."

† This series of *Pediculus*, which undoubtedly belongs to the form named *P. affinis* by Mjöberg, proves on examination to be a very inconsiderable variety of *P. capitis*. Every one of the characters given by Mjöberg is inconstant and occurs occasionally, I find, on varieties of *P. capitis* from savage races. *P. affinis* is probably a straggler from human beings, establishing itself on *Ateles* on account of a certain similarity in the blood and hair between *Ateles* and the Anthropoids as adduced by Friedenthal. On this assumption the family Pediculidæ is, as far as known at present, confined to the Old World: the Pediculinæ on Man and Apes, the Pedicininæ on the lower monkeys. If it be held that *P. affinis* is a true parasite and at no time a straggler from Man, then, in view of the very general opinion that Platyrhine and Catarhine monkeys diverged very early from one another, this Cebid *Pediculus* would have to be regarded as a very remarkable case of convergence. The question will be fully dealt with in the 'Annals and Magazine of Natural History.'

These facts are of some interest, being contrary to what has been found to obtain in the larvæ of three species of *Polyplax* (**6**, p. 271), where the chætotaxy of the head and thorax is fully adult in Stage I., while that of the abdomen in the same stage agrees with *Pediculus* in presenting great differences.

### Genus PEDICINUS Gervais.

Several species of Pedicininæ, including one undoubtedly new form from *Colobus caudatus* Thos. (Family Cercopithecidæ), are contained in the collection. But this group is difficult and in some confusion, and the Society's material is insufficient to justify any attempt to straighten things out. Fahrenholz's paper (**5**, p. 12) clears the way for a revision, which can best be effected by a study of the male copulatory apparatus.

Only the two following species have been definitely named :—

PEDICINUS RHESI Fahrenholz (**5**, p. 16).

A few specimens from *Macacus inuus* (now known as *Pithecus inuus* Linn.). Fahrenholz's specimens were obtained upon a "*Macacus rhesus*." Both hosts belong to the Cercopithecidæ.

### Genus PHTHIRPEDICINUS Fahrenholz (**5**, p. 22).

PHTHIRPEDICINUS MICROPS (Nitzsch) * (**5**, p. 25).

A single female from an unrecorded host.

### Genus POLYPLAX Enderlein.

POLYPLAX SPINULOSA (Burm.) (**7**).

Numbers of specimens of this cosmopolitan species caught on the cosmopolitan rat (*Epimys norvegicus* Erxl.). The larvæ and the male copulatory apparatus are described and figured in the P. Z. S. 1915, pp. 256, 268, text-figs. 7, 15, 16).

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* [The parentheses around the names of authors placed after scientific names in this paper are used in accordance with Article 23 of the International Rules of Nomenclature (Proc. 7th Int. Cong. Boston, 1907, p. 44 (1912)).—EDITOR.]

### *Explanation of the Terminology used in describing the Male Copulatory Apparatus of Anoplura and Mallophaga.*

In almost all Anoplura and Mallophaga, it is easy to recognise at once the basal plate and the parameres. The basal plate—probably double in origin as two longitudinal apodemes—is a chitinous lamina usually, if not always, longer than broad, to the posterior lateral angles of which are articulated the two chitinous appendages known as parameres. Between the parameres is the mesosome, the parts of which are not so readily made out unless a specimen be carefully dissected. Fundamentally, the mesosome is a sac—the enlarged and extrusible end continuous with the ductus ejaculatorius. This sac—called by Mjöberg "the preputial sac"—presents two regions of chitinisation—a distal and a proximal. At the distal end is the rod of the penis or virga, with frequently a splint on each side called the telomere, and one below—the hypomere*. At the proximal end are the endomeres, usually strongly chitinised bands or rods, one on each side, supporting the membrane of the sac, of which they are only local thickenings. The whole of the genitalia exhibit enormous variety in form, and the mesosomatic parts in particular are occasionally so much modified that it becomes difficult to recognise their conformation to the general plan just sketched out above. For example, in many Philopterids, such as *Docophorus*, no sacular portion of the apparatus is recognisable, and the distal chitinisations lie well back within the proximal, the whole forming a solid and compact mesosome. The above terms are, therefore, adopted solely for convenience of description.

### Genus LINOGNATHUS Enderlein.

LINOGNATHUS CAVIÆ-CAPENSIS (Pallas) (8, p. 37). (Text-fig. 1.)

The ample material of this species submitted provided the opportunity for a dissection of the copulatory apparatus of the male, which hitherto has been neither described nor figured. The accompanying text-illustration (text-fig. 1) makes it easy to dispense with a good deal of circumlocutionary description.

*Basal plate*: A fairly long and narrow rod, the posterior end of which, for the purpose of affording articulation to the parameres, is widened, and each posterior lateral angle drawn out into a short process, leaving the lower margin of the plate concave between.

*Parameres*: Each paramere at the base is fairly broad and fits in around the concave lower margin of the basal plate. Halfway down on the inner side, each paramere shows a very pronounced thickening or nodule of chitin. At the extreme distal end the small acute termination of the paramere bends in sharply to face its fellow.

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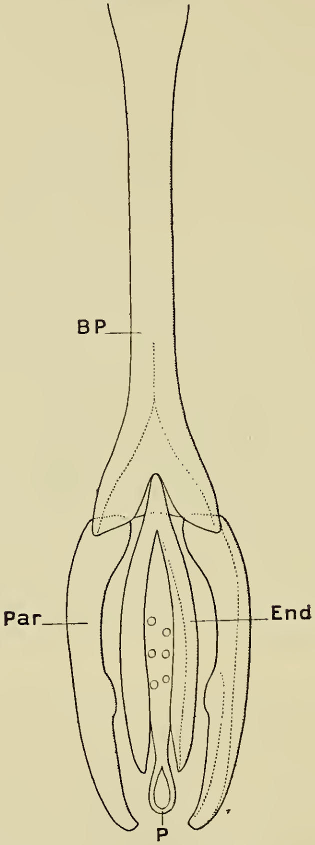
* For these terms, first applied to specialised Philopterid forms, see Waterston, Annals of the S. African Museum, vol. x. pt. 9, 1914, p. 279.

Text-figure 1.



*Linognathus caviæ-capensis.* Male copulatory apparatus. × 378.

*BP.* Basal plate; *End.* endomere; *P.* penis; *Par.* paramere.

*Endomeres*: These are fused at the base into a single piece. The two limbs support the "preputial sac," on the lower side of which, in the retracted condition, may be observed six large pustular alveoli, probably containing minute directive hairs or other form of sense-organ.

*Penis*: At the tip is an aperture, surrounded by a noose of chitin. This is probably the opening for the seminal fluid.

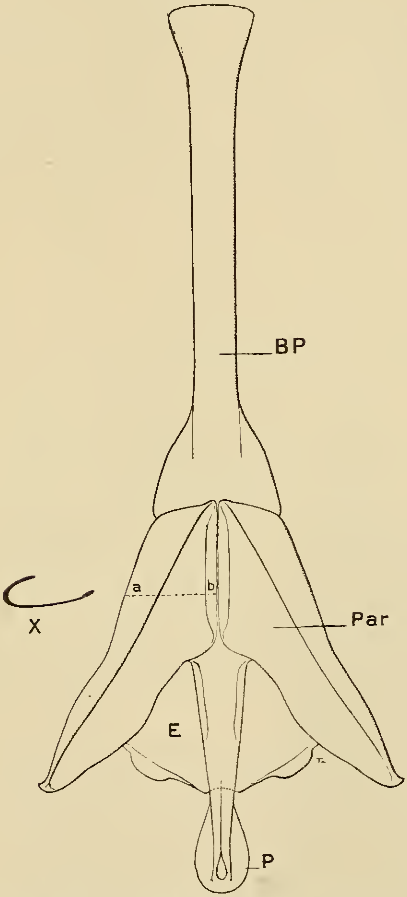
*Telomeres*: Not separately distinguishable.

The *hypomere* is in the form of a thin flat band, running back from the tip of the penis along the lower surface of the sac.

Linognathus limnotragi Cummings (8, p. 36). (Text-fig. 2.)

Several specimens collected on *Limnotragus gratus* Scl. (Congo) and also on *Taurotragus oryx*.

Text-figure 2.



*Linognathus limnotragi.* Male copulatory apparatus. × 232.
*BP.* Basal plate; *E.* endomere; *P.* penis; *Par.* paramere;
*X.* cross-section along the line *a–b*.
The parameres are dissected apart.

The following is a description of the male copulatory apparatus, unfortunately omitted from the original description:—

*Basal plate*: Rod-like, with an expanded posterior end; just as in the preceding species. The posterior lateral processes, however, are less developed, and the posterior margin of the expanded posterior end is only slightly concave.

*Parameres*: These are of a remarkable type (text-fig. 2). Proximally they are broad blade-like pieces which meet each other (but do not fuse) beneath the mesosome in a fairly long median groove, then dorsally wrap themselves around the mesosome lying between them, forming a kind of sheath, from the end of which the penis projects, and, like the somewhat narrower distal ends of the parameres, curls up dorsalwards.

*Penis*: As in *L. caviæ-capensis*, this ends in a loop-like aperture, of much smaller size, relatively. On each side of it may be discerned, under a high power, a small telomere, the three together forming a complex, running backwards into a broader basal part between the parameres.

The part " E " I regard as the endomeral part of the copulatory tube. These parts are reconsidered on p. 266.

### LINOGNATHUS TIBIALIS (Piaget) (2, p. 646).

6 ♀ ♀ from an unrecorded host.

### LINOGNATHUS GAZELLA Mjöberg (4, p. 157).

5 ♀ ♀ from an unrecorded host.

### LINOGNATHUS PITHODES, sp. n. (Text-figs. 3–5)

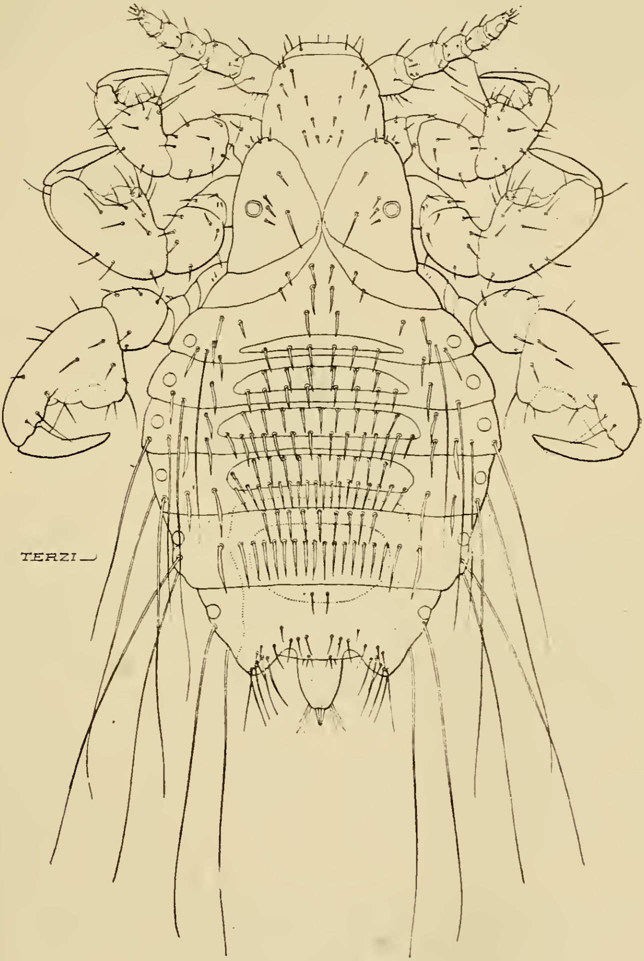
2 ♂ ♂ and 12 ♀ ♀ from the Indian Antelope *Antelope cervicapra* Linn. Lucas described a variety of *L. tibialis* from the same host (Ann. Soc. Ent. France, 1847, p. 534).

The species about to be described may at once be distinguished from all other members of the genus at present known by the presence on the abdomen of the male of a segmental series of tergites, each possessing a row of closely placed spines or " thorns," short and very thick, and set in a perfectly straight alignment (see text-fig. 3). The trefoil-shaped appearance of the posterior end of the abdomen in the male is also an obvious character for the species.

The genus *Linognathus* has hitherto been in part defined by the *absence* of abdominal sclerites; but, as in other respects the new species is typically linognathoid, it is better to expand the diagnosis of the old genus than to create a new one.

*External Form.* MALE.—A stout insect with a large tun-shaped abdomen. *Head*: Short and broad, almost as broad as long, extending only a little beyond the antennæ. In front the head is truncate and broad, the lateral angles rounded. Mouth opens ventrally in the middle of a circle of broad-banded chitin, the anterior semicircle of which runs across the dorsal surface of the truncate front of the head and then down on each side, the posterior semicircle being composed of thinner chitin. The post-antennal region of the head is a little broader than the pre-antennal, and the two margins are parallel to one another. *Antennæ*: Elongate, graduated in width from the base to the tip (see measurements, p. 266). Cephalic apodemes as usual in *Linognathus* absent, the head fitting into a deep V-shaped cleft of the prothorax. *Thorax*: Broader than the head. Legs powerful, particularly the coxæ. The first pair of coxæ are large enough to reach forward on each side nearly as far as the

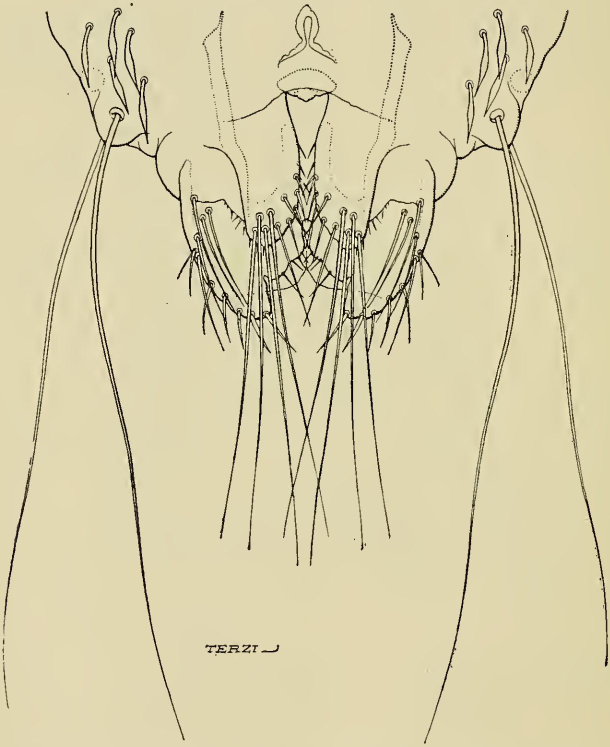
Text-figure 3.



*Linognathus pithodes*, ♂. × 68.

antennæ. The coxæ on the same side are contiguous, but widely separated from those of the other side. Femora short and very convex in the postaxial margin. *Abdomen*: Broad, globose. The tip of the copulatory apparatus projects from the tip of a long, stout, genital papilla shaped like a finger and terminating the abdomen. It lies between two smaller processes which project only a little, and are formed by the pleurites of the last segment. Dorsally there are five transverse strips of light brown chitin forming the tergite on each of segments 3 to 7, the anterior ones most clearly delimited.

Text-figure 4.



*Linognathus pithodes*, ♀. Ventral surface, showing gonopods. × 46·5.

*External Form.* Female.—*Abdomen*: A little longer and narrower than in the male. Tergites absent. As in the female of *L. tibialis*, *L. fahrenholzi* and others, the end of the abdomen is drawn out into a pair of processes, which in this species are quite short and project only a little beyond the terminal tergum.

The gonopods measure ·2 of a millimetre in length and ·09 wide, each with a strong chitinous external margin (text-fig. 4).

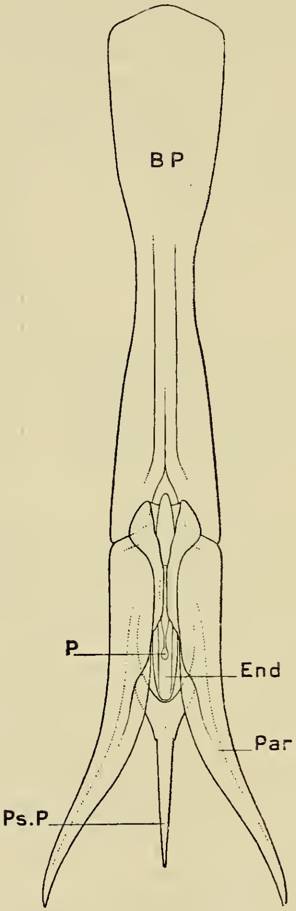
*Chætotaxy.* MALE.—Remarkable for the presence along the abdominal tergites of a segmental series of perfectly straight transverse rows of closely placed spines—short, thick, and dark brown in colour. *Head:* Several well-spaced hairs on the chitinous circle around the mouth. Dorsal surface: hairs arranged as in the text-figure. Ventral surface: a stout hair on each side at about the level of the postaxial margin of the antenna. *Thorax:* A stout bristle on each side of the pronotum. The usual mesothoracic bristle; between it and the spiracle on each side three small spiny hairs. Two spines on the hind margin of the metanotum. *Abdomen:* The rows of modified short spines in straight alignment on the dorsal surface are given in the following table:—

| | |
|---|---|
| Segment 1 | 2 |
| ,, 2 | 2 |
| ,, 3 | 5<br>5 |
| ,, 4 | 8<br>9 |
| ,, 5 | 14<br>9 |
| ,, 6 | 18<br>9 |
| ,, 7 | 16 |

On the tergum of segment 8 are two bristles, while across the tergum of the terminal segment is a row rather difficult to observe of eight or nine small hairs which connect up with two small groups of hairs, one on each pleurite. On the pleuræ of each segment, dorsally, numerous scattered lanceolate spines. A pair of small hairs at the tip of the genital papilla. Other hairs as in text-figure 3. On the ventral surface the spines are mostly lanceolate in shape, more widely spaced and fewer in number, arranged in six rows. In the first and second there are four; in the third, eight; in the fourth, nine (the two middle ones being longest); in the fifth, twelve (the four middle ones being longest); in the sixth, ten (the four middle ones being longest and the lateral ones irregularly arranged). On the sternum of segment 8 there are two long bristles and a lanceolate spine on the inside of each pleurum.

*Chætotaxy.* FEMALE.—*Head:* As in the male; but the hairs on the dorsal surface are stouter and longer. *Thorax:* As in the male. *Abdomen:* Both dorsal and ventral surfaces covered with a large number of stout lanceolate spines arranged in no definite pattern or order. On the tergum of the eighth segment, somewhat apart from the others, are two extra long hairs. On the eighth sternum, in the middle, just before the gonopods, are four elongate bristles in two pairs. Between the two couples is a patch of minute hairs, ten in number. Tips of gonopods with several elongate bristles and a patch (situated chiefly on the dorsal surface of the gonopod) of smallish thin hairs. Pleura of segments 3 and 4 with a single long bristle each. Those of segments 5, 6, 7, and 8 each with two.

Text-figure 5.



*Linognathus pithodes.* Male copulatory apparatus. × 178. The parameres have been pulled apart.

*BP.* Basal plate; *End.* endomere; *P.* penis; *Par.* paramere; *Ps.P.* pseudo-penis.

*Coloration.*—The thicker parts of the exoskeleton are of a warm brown colour, as, for example, the band on the anterior margin of the head, the "thumbs" and claws of the second and third pairs of legs, and also at the extremity of the abdomen in the bays, one on each side of the base of the finger-shaped genital papilla in the male. The tergites are of a light brown colour, and each antennal segment is similarly banded. Across the distal broad part of the tibiæ of the front legs is a comparatively narrow, transverse, brown band. Coxæ of a uniform deep brown colour.

*Male Copulatory Apparatus* (text-fig. 5).—*Basal plate*: Broader than the plate in the two preceding species of *Linognathus*. At the base it is slightly bifid, each short limb being a process for the articulation of a paramere. A suture is observable in the median line of the plate, extending from the cleft between the two basal processes up to just beyond half the length of the plate. This groove or suture, which indicates the originally double nature of the plate probably throughout the Order, lies in a narrow thickening in the mid-line of the plate, on each side of which the chitin is flattened and thinner. At the upper end the plate is of a uniform thinness and is a little broader. *Parameres*: These are long, narrow, and tapering to an acute apex. Towards the base each paramere develops on its inner side a kind of supporting ledge or shelf which runs in below the mesosome. The outer side becomes thickened and turns in almost at right angles on arriving at the basal plate, with the limb of which on each side of the cleft it is connected. *Penis*: Although it is impossible to speak definitely when the apparatus is in the retracted state, I think it is fairly safe to assume that the loop-like apertures marked *P* in text-figs. 1, 2 & 5 are homologous. Now, in *L. limnotragi* this aperture obviously lies at the tip of the penis, whereas in the present new form it is seen lying within the chitinous bars marked *End.* It may therefore be supposed that the distal end of the penis-tube with the aperture is here telescoped into the firm chitinous base, which may be either endomeral or the base of the penis. The pseudo-penis (*Ps.P.*) is also probably an endomeral chitinisation.

*Measurements (millimetre scale).*

| | ♂. | | ♀. | |
|---|---|---|---|---|
| | Length. | Breadth. | Length. | Breadth. |
| Head ............... | ·29<br>(median) | ·20 | ·35<br>(median line) | ·17 |
| Thorax ............ | ·22 | ·30 | ·30<br>(lateral margin) | ·35<br>(at base) |
| Abdomen .. ...... | ·80 | ·64 | ·85 | ·65 |
| Total ......... | 1·31 | | 1·50 | |

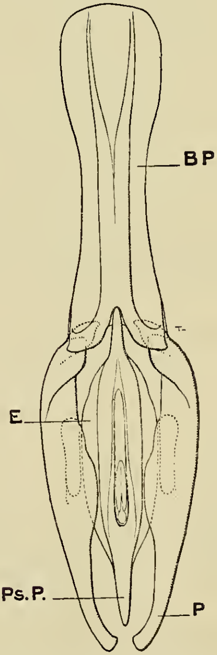
*Antenna of male.*

| | Length. | Breadth. |
|---|---|---|
| Segment 1 ... ........ | ·064 | ·080 |
| „ 2 ......... .. | ·076 | ·056 |
| „ 3 ........... | ·050 | ·040 |
| „ 4 ........... | ·040 | ·040 |
| „ 5 ........... | ·044 | ·038 (at base)<br>·032 (at tip) |
| Total ........ | ·274 | |

### *Comparison with the Male Copulatory Apparatus in* Linognathus *from Eland.*

Subjoined, with a discussion, is a description of the male copulatory apparatus of a new variety of *Linognathus tibialis*

Text-figure 6.



*Linognathus tibialis.* Male copulatory apparatus. × 140.
*BP.* Basal plate; *E.* endomere; *P.* paramere; *Ps.P.* pseudo-penis.

from an Eland in the Zoological Gardens at Edinburgh. It is interesting to include a description and figure of the Eland *Linognathus* here for the purpose of comparison.

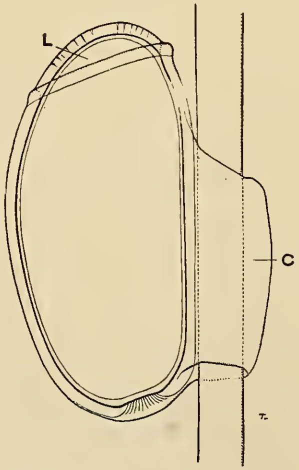
*Basal plate*: This closely resembles the plate of *L. pithodes* in the bifid lower end, the median suture, and median raised strip. *Parameres*: Proximally broad and fitting around the mesosome closely, a feature in which they resemble those of *L. limnotragi* (which wrap in around the mesosome extensively) and *L. pithodes*, in which there is a broad leaf-like shelf (see p. 264). They resemble *L. caviæ-capensis* in the possession on the inner concave surface about halfway down of an area of thickened chitin, longer than the so-called "nodule" in the Procavian *Linognathus*. The appearance suggests, in both instances, a strengthening of the middle part for clasping the mesosome. *Mesosome*: As in *L. pithodes*, a pseudo-penis is present and fused with the rest of the endomeral chitinisation (text-fig. 6). A thin ledge of thin chitin runs along the outside of each of the two parallel bars. Between them lies the aperture and what I interpret as the true penis.

### Genus HYBOPHTHIRUS Enderlein.

HYBOPHTHIRUS NOTOPHALLUS (Neumann) (**8**, p. 44, and **9**). (Text-figs. 7, 8.)

Eggs, larvæ, and adults, male and female, from *Orycteropus afer* (Pall.).

Text-figure 7.

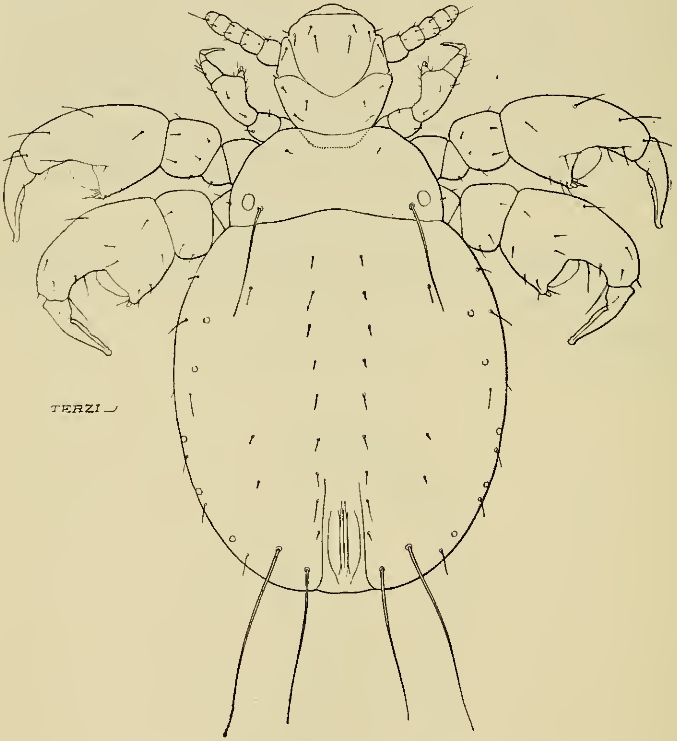


*Hybophthirus notophallus.* Egg.
*C.* Cement; *L.* lid. × 36.

Both Enderlein and Neumann (see **8**, p. 44) have described this isolated louse-form; but Neumann's description is much the fuller, and includes a figure and description of the male copulatory apparatus. The Society's specimens agree *in toto* with those described by Neumann. In Enderlein's figure there is a discrepancy in the metanotum which I do not understand.

I have re-examined the male copulatory apparatus and the following description supplements Neumann's and brings the parts under recently devised terminology. *Basal plate*: Fairly long and broad, broader in front than behind. The broader anterior end is somewhat spatulate, the concave side facing dorsally. *Parameres*: Strong, fairly straight rods. They bulge a little and then immediately narrow before the tip. The tip is short and turned outwards. *Mesosome*: The parts between the parameres are merged into a single structure, in which the following parts may be distinguished:—Two bars, one on each side (probably the endomeres), and apically a triangular plate—the pseudo-penis. On the dorsal surface, projecting from about the level of the distal ends of the endomeres, is a small median

Text-figure 8.



*Hybophthirus notophallus.* Larva, Stage I. × 39.

chitinous papilla, which is probably the *penis*. The larger distal end of this papilla is supported on each side by a chitinous margin—these latter parts, lower down, running into one another and forming a narrow neck.

The egg is shown in outline in text-fig. 7. The egg is large and fastened to the hair by a very strong thick cement along a straight inner surface, equal almost to two-thirds its total length. The shell and the lid are quite smooth. The micropyle apparatus on the lid consists of a number of very minute canals, which do not, as in many Anoplura, project as papillæ on the lid. Length 1·5 mm.; greatest width ·72 mm.

*Larva, Stage I.* (text-fig. 8).—Head is very rounded. Abdomen without sclerites, ovate, smooth margin all the way round. Thorax with straight hind margin. Almost bald, except for two mesonotal hairs and two long hairs on each side of the last segment of abdomen. Other minute hairs as shown in the text-figure. Described from a single specimen.

*Measurements (millimetre scale).*

| | Length. | Breadth. |
|---|---|---|
| Head ...................... | ·40 | ·38<br>(behind antennæ) |
| Thorax .................. | ·40 | ·72<br>(at base) |
| Abdomen .............. | 1·20 | 1·02 |
| Total ...... ... | 2·00 | |

Length of antenna ......... ·33 mm.

## MALLOPHAGA.

### Genus Boopia Piaget.

**Boopia tarsata** Piaget (2, p. 599). (Text-fig. 9.)

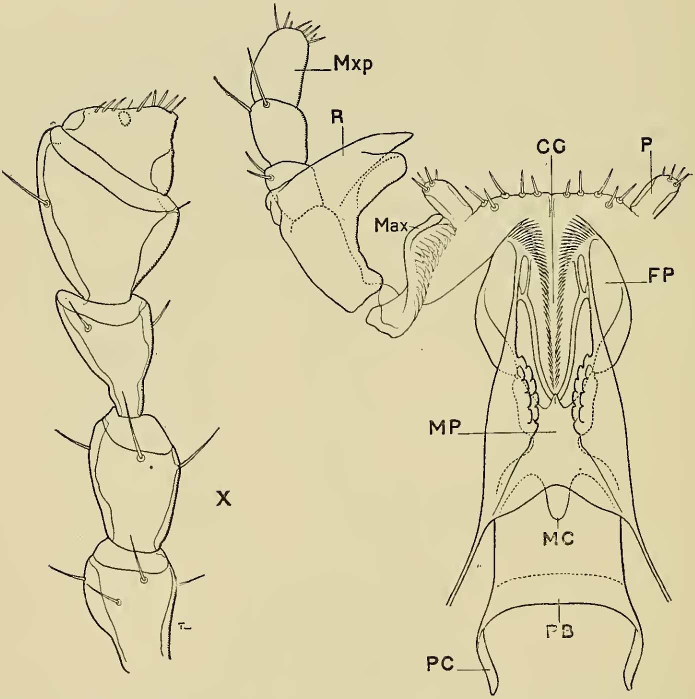
Twenty-two specimens from *Phascolomys mitchelli* Owen. Piaget's specimens were taken on a *P. fossor*.

In all the males the copulatory apparatus was unfortunately retracted. It is practically impossible to draw out these parts in a dead specimen, and in our present state of knowledge very unsafe to describe such a complex structure as they present so long as they are withdrawn within the abdomen.

*Mouth-parts.*—A brief reference to the œsophageal sclerite in *Boopia* is made in my paper in the P. Z. S. for 1913, p. 138. The following description confirms the statement there made and extends it, all parts of the mouth being passed in review.

The text-figure includes the antenna (text-fig. 9). Between the so-called paraglossæ the front margin of the *labium* is a little concave in the middle and somewhat swollen on each side at the base of each paraglossa. Each swollen patch carries several small spiny hairs. *First maxillæ*: For the palpi, see text-figure. The *lobes* are twice as long as broad. The inner surface densely studded with small curved hooks, those at the distal end longest. *Mandibles*: The *right* mandible is roughly quadrilateral, the two distal lateral angles being formed by two distinct

Text-figure 9.



*Boopia tarsata.* Mouth-parts. × 300.

*CG.* Ciliated groove; *FP.* fringed plate; *MC.* median cornu; *MP.* main plate of lyriform organ; *Mxp.* maxillary palpus; *P.* paraglossa; *PC.* post. cornu; *PB.* post. band; *R.* right mandible. *X.* Antenna.

apices—one acuminate, the other broad and rounded—separated from one another by a bay. The *left* is less powerful, with two acuminate apices—one alongside the other, and one a little longer than the other. *Isopogometric apparatus*: The text-figure shows the peculiarly complex framework on which this apparatus is held together. The main plate of the pharyngeal sclerite bears a curious resemblance to the sternum of such a

Ratite bird as *Dinornis* or *Apteryx*. The posterior lateral pieces are produced some way backwards and join on each side a transverse band. From each end of the transverse band a posterior cornu coils upwards on each side of the pharynx. The plate also has a posterior median process and two anterior lateral processes. The latter run forward and each gives articulation to a chitinous strip which bends round at the mouth and there forms the double fringed plate. Forwards, from the pharyngeal plate between the two anterior processes, two strong narrow cords run, forming between them the "ciliated groove," but diverging and eventually curling around posterior to the fringed plate on each side, so as to turn back into a broad, somewhat indefinite sheet of rather thin opaque chitin set with teeth.

### Genus TRICHODECTES Nitzsch.

#### TRICHODECTES BREVICEPS Rudow (**11**).

8 ♀♀ from *Lama glama* L. (Family Camelidæ). Rudow's descriptions are notoriously bad, and are, as a rule, insufficient even for identification purposes. I prefer, however, to refer these female specimens to his species for the present, rather than describe them as new.

#### TRICHODECTES PARUMPILOSUS Piaget (**2**, p. 397).

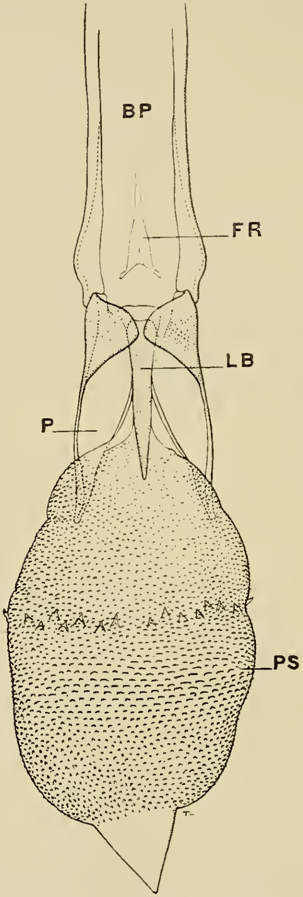
Two immature specimens from *Cervus xanthopygus* M.-Edwards, I refer very doubtfully to this species.

#### TRICHODECTES LATUS Nitzsch (**10**, p. 53). (Text-fig. 10.)

Twelve specimens, including males, from *Canis latrans* Linn.

*Male Copulatory Apparatus* (text-fig. 10).—*Basal plate*: The outline is shown in the figure. The lateral margins are strongly developed rods, the main body of the plate between being concave, so that the whole plate is of a trough-like form. At its anterior end the plate is rounded and the chitin becomes opaque and the outline indefinite. *Parameres*: At the base these are broad and leaflike, folding around the mesosome so as to form a sheath. The margins of the parameres almost meet each other over the dorsal surface at the base and similarly over the ventral surface. The *sac* is shot out between the parameres and is covered with denticles. One-half of the distance from its extremity is a transverse row of about eighteen triangular denticles, larger than the rest, and functioning probably as retinacula. On the dorsal surface the base of this sac is strengthened by a flat lanceolate splint of chitin, with a broader base (at the lower margin of the basal plate) and a much narrower distal end towards the tips of the parameres. When the apparatus is retracted, this lanceolate band at about halfway is bent downwards and back upon itself, so that in side view it appears as an enigmatic loop. Between the two lateral margins, in the clear space at the base of the plate, may be seen a small forked rod, the fork pointing forwards. I am unable to say definitely whether this is the penis-rod attached to the end of the extrusible sac, or whether it is merely a median chitinisation of the basal plate.

Text-figure 10.



*Trichodectes latus.* Male copulatory apparatus. × 200.

*BP.* Basal plate; *FR.* forked rod; *LB.* lanceolate band (endomeral); *P.* paramere; *PS.* preputial sac.

TRICHODECTES CRASSUS Nitzsch (**10**, p. 53).

Eighteen specimens from the Common Badger (*Meles meles* Linn.).

The male copulatory apparatus of this species agrees very closely with that of the preceding species. *T. pinguis* N. also presents a close resemblance in the male genitalia to *T. latus*. In a revision and splitting up of this large and unwieldy genus, these are facts which should be borne in mind. (Concerning this subject, see also p. 283.)

### TRICHODECTES CORNUTUS Gervais (**12**).

One female and two larvæ from *Gazella euchore*, now known as *Antidorcas euchore* Zimm. Gervais's specimens were collected on *Antilope dorcas*. Taschenberg (**13**, p. 220) identifies the species with Rudow's *T. longiceps* (**11**, p. 110), taken on *A. arabica*. Neumann (**14**, p. 626) records it from *Hippotragus equinus*. But, as Piaget remarks, the species requires to be examined again and described with more care.

### TRICHODECTES HEMITRAGI, sp. n. (Text-figs. 11, 12.)

The material on which the following description is based consists of 13 females from the Tahr (*Hemitragus jemlaicus* Ham. Smith).

This new parasite is of considerable interest, on account of certain features in the anatomy of the mouth-parts, which are figured and detailed below. It is sufficient here to say that the pharyngeal sclerite or lyriform organ, upon superficial inspection apparently absent, proves on dissection to be present, but in so highly modified a form, that it must be considered unique in the Trichodectidæ so far examined, while it diverges greatly from the typical form of the organ in the Mallophaga as a whole (compare text-fig. 12 with text-fig. 16). This is the more interesting, as *T. hemitragi* ♀ is unmistakably a Trichodect, and presents, with this exception, no particularly novel characters. The male, however, is yet to be discovered, and may prove to rank as a distinct genus.

In examples of *Docophorus bisignatus*, from the Storks and Ibises, I have pointed out an instance (**20**, p. 134), very similar to the present one, of an abrupt deviation in the form of the œsophageal sclerite from that of the rest of the Mallophaga, where, particularly in *Docophorus* and *Trichodectes* and in the Ischnocera generally, it presents a fairly uniform appearance.

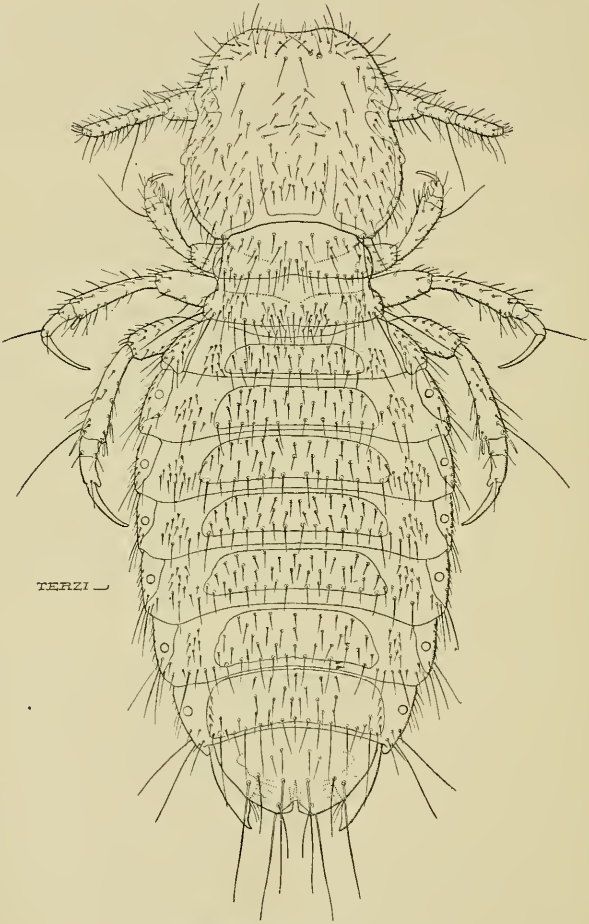
It would be premature to discuss the reason for this fundamental change in the character of this organ, occurring so abruptly among forms not otherwise anomalous, until our knowledge of the function of the isopogometric apparatus is more exact and fuller. But it is, in any event, a very remarkable fact.

It may be pointed out that the pharyngeal sclerite is an internal organ, and in both the cases mentioned above is invisible without dissection. In these instances, therefore, a purely superficial diagnosis could only have resulted in the omission of an important and deep-rooted morphological difference—a character which, if external, would probably entitle the species to generic rank, in the opinion of most of the systematic workers in this Order.

The following is a description:—

*External Form* (text-fig. 11). FEMALE.—*Head*: Preantennal area quite short. No frontal sinus, front margin straight or very slightly concave, with a narrow marginal band. Inferior "hair-canal" absent or obsolete. Temples very rounded and swell outwards behind the eye, making the head a little broader behind the antennæ than in front. Dorsally, two occipital

Text-figure 11.



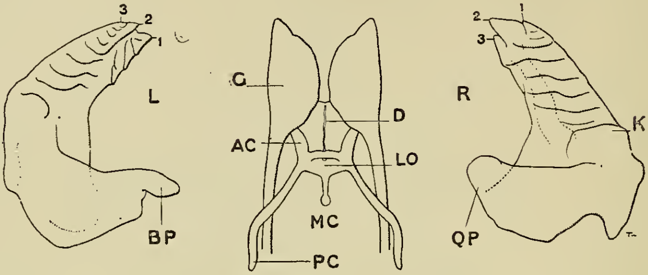
*Trichodectes hemitragi*, ♀. × 55·5.

bands as rafters of the skull run forward towards the mandibles, and are straight and parallel to one another. In front of each antenna is a fairly large incrassation, rounded in form and connected by a narrower neck with the margin. *Thorax*: Narrower than the head, with straight metanotal margin and convex lateral margin. *Abdomen*: Broader than the head, elliptical. A brown band on the dorsum of the segments, those on 5, 6 and 7 being the deepest in colour and in length. *Gonopods* (see text-fig. 11).

*Chætotaxy.* FEMALE.—*Head*: Dorsal surface covered with a great many fairly short hairs. Antennæ also set with a great many hairs, long and short, including one long one preaxially and a row of four long ones dorso-postaxially in segment 2, and on segment 3, along the postaxial margin, a straight row of six fairly long hairs. Ventrally, postantennal area appears to be quite bare. On the preantennal area there are numerous long bristles between the antenna and the frontal margin. *Thorax*: Dorsal surface set with small bristles, arranged as shown in the figure. *Abdomen*: Dorsal surface covered with bristles, long and short, which it is possible roughly to analyse into three transverse rows on each segment. There is, however, a small bare area inside each pleurite. Each pleurite carries numerous small hairs and two long ones, which are particularly long in segments 6 and 7. Dorsum of last segment almost bare, except for four or five long hairs in a widely-spaced transverse row. Ventral surface thickly covered with hairs, there being a particularly dense patch between the gonopods. At the extreme end of the abdomen there are two long bristles dorsally and two ventrally.

*Mouth-parts.*—Although the hair-canal in front of the mandibles may be said to be absent, it is indicated on the ventral surface by a difference in the thickness of the chitin of the margin. *Mandibles* are large and strongly ridged, the right one in almost its whole breadth lying behind the left, far forward near the front margin of the head. On the *right* one are three distinct apices, the middle one being the longest. At the base it runs in as a stout quadrangular process (text-fig. 12). Opposite this and on the dorsal surface is a large knob of dense chitin. The *left* mandible has three apices, two of which are very small and close together, and the usual narrow basal process. The transverse ridges are particularly strong, prominent, and downwardly directed at the base of the ventral tooth. Ridges are continuous in both mandibles across the surface of the mandible. *First Maxillæ*: These do not call for particular remark. *Labium*: Front margin straight with a small, short, squat paraglossa at each lateral angle. *Isopogometric Apparatus*: The pharyngeal sclerite or lyriform organ is a slender and delicate piece of chitin, consisting of two large sprawling posterior cornua, a prominent median cornu between these, a small and insignificant "nucleus" or main body, and two anterior cornua rather broad and long. The chitinous chord or duct, as usual, runs forward and bifurcates, each branch entering a "gland" or basal piece. The latter has a short posterior tendon attached to it.

Text-figure 12.



*Trichodectes hemitragi.* Mouth-parts. × 166. Labium not shown.
L. Left mandible. R. Right mandible. × 120.

*BP.* Basal process; *D.* duct; *G.* "gland"; *K.* knob; *LO.* lyriform organ; *PC.*, *MC.*, *AC.* posterior, median, and anterior cornua; *QP.* quadrangular process; 1, 2, 3. apices.

*Measurements (millimetre scale)*, ♀.

| | Length. | Breadth. |
|---|---|---|
| Head .................... | ·50 | ·52<br>(behind antennæ) |
| Thorax .................. | ·28 | ·45 |
| Abdomen .............. | 1·10 | ·84 |
| Total ......... | 1·88 | |

Length of Antenna :—

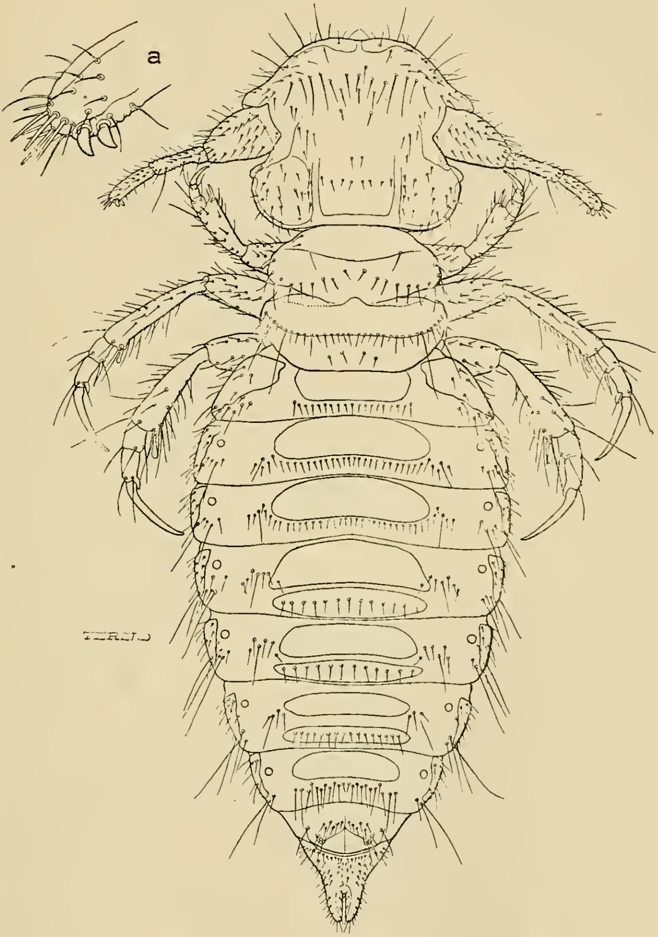
| | |
|---|---|
| Segment 1 .............. | ·070 |
| „ 2 .............. | ·100 |
| „ 3 .............. | ·120 |
| Total ...... | ·290 |

TRICHODECTES HARRISONI, sp. n. (Text-figs. 13–16.)

Several specimens, male and female, collected on the White-tailed Gnu (*Connochætes gnu* Zimm.). In the shape of the abdomen of the male, more particularly of the last segment which is produced and has a deep median bay, this new form recalls *Damalinia* and *T. forficula.* There is, however, no frontal sinus, the head being semicircular in front, and I consider its nearest allies, therefore, to be *T. forficula* P. (from *Cervus* *porcinus*) and *T. climax* N. (from *Capra hircus*), more especially the former.

The species is named after Mr. Launcelot Harrison, B.Sc., of the University of Sydney.

Text-figure 13.



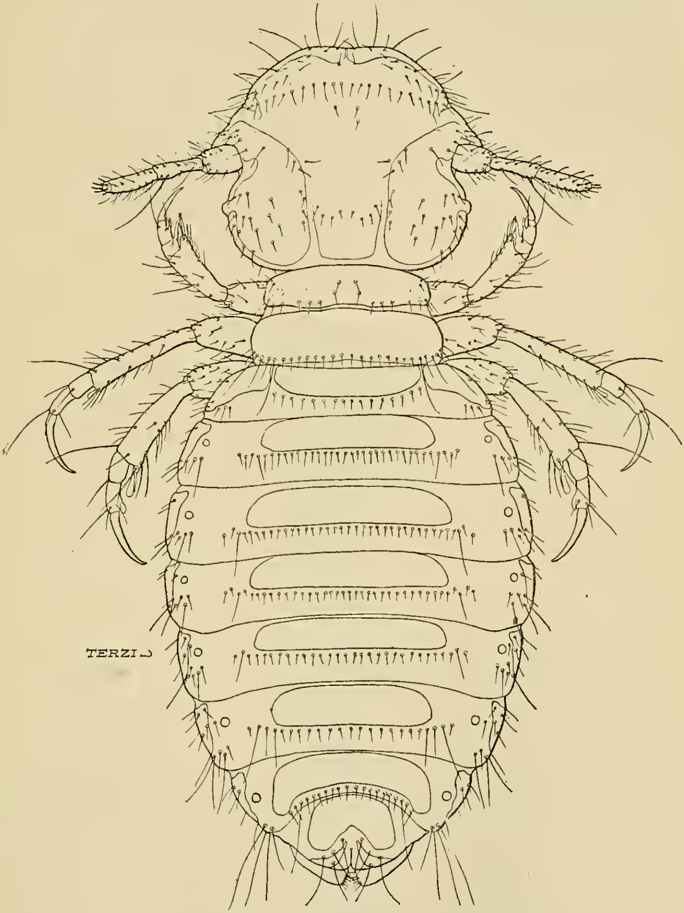
*Trichodectes harrisoni*, ♂. × about 55.

*a*. Tip of antenna, much enlarged.

*External Form*. MALE (text-fig. 13).—*Head*: Front margin semicircular. Marginal band narrow at the sides, broader across the front. Frontal sinus absent. Antennæ arise about midway, one on each side. Postantennal area as broad as the base of the preantennal semicircle. Temples rounded. Occipital margin broad; the two dorsal rafters of the skull are parallel and widely separated. There are also two ventral rafters pursuing the same course. At the occiput the dorsal and the ventral rafter of each side are united one to the other by a concave broad band forming the sides of the occipital hole. Forwards the dorsal rafters become evanescent in the chitin of the roof, just about the level of the mandibles. Each ventral rafter in front splits into two branches, the outer curling around into the posterior part of the antennary socket and the inner one apparently becoming absorbed in the thick chitin, which gives the mandibles articulation. *Antenna*: First segment large, swollen, all three segments about equal in length. *Hair-canal* absent or, at any rate, very shallow; two somewhat convergent chitinous bands run from the clypeus to the front margin of the head and indicate the sides of the canal. As in *T. climax* and others the frontal marginal band is thickened, with a narrow, median, longitudinal, white cleft. In a greatly developed hair-canal, such as *T. subrostratus* N. possesses, there is no band crossing the frontal sinus, the lateral marginal bands, one on each side, running down the sides of the hair-canal. *Thorax*: Narrower than the head. There are two distinct parts—pro + mesothorax and metathorax or prothorax and meso + metathorax. The latter is a little the broader. Lateral margins of both are rounded. Coxæ of first pair of legs lie close to one another in the centre. First pair of legs short, the tibiæ of the second and third pairs remarkably long. *Abdomen*: Tapers elegantly to the anal extremity. The tip is bifid. The material at my disposal is insufficient to determine the precise morphology of the bifid tip. In *Damalinia*, according to Mjöberg, it is the produced sternite of the last segment. There are two other species of *Trichodectes* with bifid tips to the abdomen, viz., *T. forficula* P. and *T. appendiculatus* P., but I have not been able to examine either of these for comparison. A tergite on each of the first three segments; but each tergite gives a suggestion of being double, and in the following three segments each tergite is plainly divided in half by a transverse light-coloured band. It is possible that these divisions are only colour-differences. On the penultimate segment, a small tergite. The termination of the abdomen is of a clear whitish chitin. A single sternite in each segment. Each sternite, even in the posterior segment, is an integral whole, so that a genital plate may be said to be absent, although the last two sternites are, on each side, bracketed together by a lateral band of brown chitin.

*External Form.* FEMALE (text-fig. 14).—The usual sexual differences in the antennæ. *Abdomen*: Ovate. A single tergite and sternite on each segment, dark brown in colour. Tergite 1 fits the whole space between the pleurites. In the tergites that follow, there is a clear space laterally between tergite and pleurite. The gonopods are fairly broad, ear-like plates projecting beyond the end of the abdomen. They cover the sternal surface and lie transversely across the end of the abdomen, their concave surfaces uppermost, adpressed against the sternal abdominal surface.

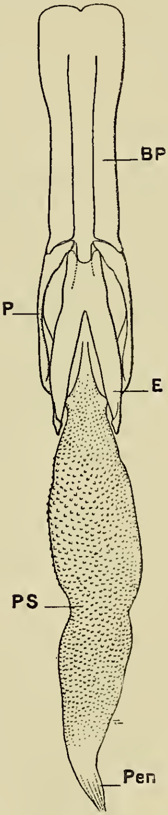
Text-figure 14.



*Trichodectes harrisoni*, ♀. × about 56.

*Chætotaxy.* Male.—*Head*: A great many scattered hairs over preantennal area dorsally, and also over dorsal surface of the temples. Median dorsal postantennal area, between the two longitudinal bands, bare except for a transverse row of short hairs. Ventrally, numerous short hairs in preantennal area on each side of the hair-canal; postantennal area apparently bare. *Thorax*: Small scattered hairs on pronotum and a row along posterior margin. A transverse row of short hairs on metanotum. Other hairs as in the figure. *Abdomen*: A transverse row of quite short, closely-placed hairs along the posterior margin of each tergite; in those segments where two tergites are present, the row runs across the front margin of the second. A small semicircle of short hairs on anterior lip of genital opening. The whole of the dorsal surface of the apex of the abdomen studded with short hairs. Ventrally, a row of hairs along posterior margin of each sternite. Fewer hairs on ventral surface of the end of the abdomen than on the dorsal. Other hairs as in the figure.

Text-figure 15.



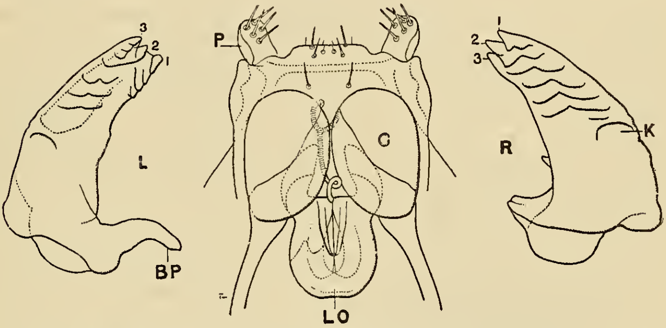
*Trichodectes harrisoni*. Male copulatory apparatus. × 118·5.

*BP*. Basal plate; *E*. endomere; *P*. paramere; *Pen*. penis rod; *PS*. preputial sac.

*Chætotaxy.* FEMALE.—As in the male, except in the region of the genital opening. Here, a fringe of hairs runs around the margin of each gonopod, and there is a patch of short ones between the gonopods at the base.

*Male Copulatory Apparatus.*—This resembles that of *T. forficula* according to Piaget's rather obscure figure. *Basal plate*: Consists of two straight parallel-sided marginal bands, parallel to one another, with a transparent and apparently membranous median strip between. At its base for the articulation of the paramere each band is obliquely truncate. *Parameres*: Much shorter than the endomeres. Each paramere in the mid-part of its length is a narrow rod; towards the base its inner margin runs out to form an inner trochanter, as broad as the band of the basal plate to which it is attached. Distally, the paramere broadens dorso-ventrally and forms a concave flange, the concave surface on the inside. *Endomeres*: Large pieces, the tips reaching almost to the genital opening. They are fused into one piece at the base and form a single forked sclerite, concave dorsally, so as to hold the sac. Each limb of the fork is quite broad, but has an acute apex and carries a small nodular tooth subapically. The sac is long, covered with small denticles. *Penis* and *telomeres* are developed on the distal end, but are very delicate and transparent, and hard to make out (text-fig. 15).

Text-figure 16.



*Trichodectes harrisoni.* Male mouth-parts (maxillæ not shown). × 200.
L. Left mandible. R. Right mandible. × 168.
*G.* Gland; *K.* knob; *LO.* lyriform organ; *P.* paraglossa; 1, 2, 3. apices.

*Mouth-parts* (text-fig. 16).—*Mandibles*: These resemble those of *T. hemitragi*, than which, however, they are relatively much smaller and less powerful. When in repose, moreover, only the distal ends overlap, that of the right being a little behind and above (on the inside of) the left. In each there are three apices; on the *right* there is the same stout quadrangular process, with the large knob opposite. On the left there is the usual sharp basal process (present in the left mandible of most Mallophaga). On both mandibles are transverse ridges fewer than in *T. hemitragi*. *First Maxillæ*: Small lobes that call for no particular remark. *Labium*: "Paraglossæ" short and columnar, rounded at the tips, firm outer surface. Five inwardly directed spines on each distal end. No lobes, labial margin straight. Ten minute hairs, set in large alveoli on the labium, and further back two short hairs, one on each side. *Isopogometric Apparatus*: No posterior cornua on the lyriform organ. Anterior cornua broad, and almost as long as the "nucleus."

*Measurements (millimetre scale).*

| | Length. | | Breadth. | |
|---|---|---|---|---|
| | ♂. | ♀. | ♂. | ♀. |
| Head ............... | ·45 | ·51 | ·56 (in front of antennæ) | ·54 |
| Thorax ............ | ·32 | ·22 | ·40 (metathorax) | ·44 (metathorax) |
| Abdomen ......... | 1·35 | 1·20 | ·75 (segment 3) | ·88 (segment 3) |
| Total ...... | 2·12 | 1·93 | | |

| Length of Antenna. | ♂. | ♀. |
|---|---|---|
| Segment 1 .............. | ·150 | ·076 |
| „ 2 .............. | ·135 | ·012 |
| „ 3 .............. | ·110 | ·012 |
| Total ...... | ·395 | ·10 |

| Length of Legs, ♂. | 1st. | 2nd. | 3rd. |
|---|---|---|---|
| Femur .................. | ·016 | ·180 | ·02 |
| Tibia + tarsus ...... | ·200 | ·345 | ·028 |
| Claw (curved) ......... | ·060 | ·120 | ? |
| Total ...... | ·276 | ·645 | — |

TRICHODECTES OVIS Linn.

Specimens from *Ovis musimon* Linn. Also been recorded from *O. aries*, *O. ornata*, *O. melanocephala*.

TRICHODECTES sp.

12 ♀ ♀ from *Capreolus capreolus* Linn. The specimens belong to the much confused *tibialis*-group of *Trichodectes* from Deer. It is thoroughly unsafe to identify specimens of this series from females until the confusion, caused chiefly by the absence of morphological evidence in previous descriptions and figures, has been dispelled. These females certainly are not *T. tibialis*, but agree most with some unnamed Trichodects from Reed-Buck (Africa), shown me by Mr. Waterston among some material belonging to the Imperial Bureau of Entomology.

### Genus EUTRICHOPHILUS Mjöberg.

EUTRICHOPHILUS SETOSUS (Gieb.) (**10**, p. 56). (Text-fig. 17.)

37 ♀ ♀ from *Erithizon dorsatum* Linn.

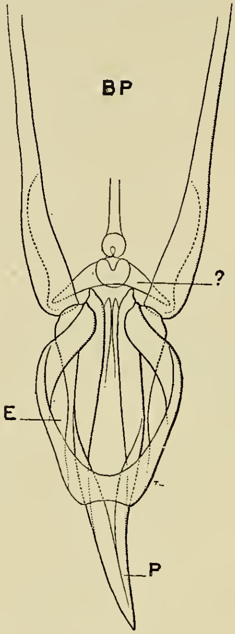
I have been able to make a preparation of the male copulatory apparatus from a male contained in a tube of this species presented to the British Museum by the Hon. N. C. Rothschild. In many species of Trichodectidæ, males are rare and in *T. scalaris* N. unknown.

The Family Trichodectidæ consists at present of but three genera—*Trichodectes*, *Damalinia*, and *Eutrichophilus*. Before *Damalinia* and *Eutrichophilus* were split off in 1910 by Mjöberg, the old genus *Trichodectes* was simply a miscellany, which still requires breaking up into genera—a by no means easy task, on account of the difficulty in finding convincing characters. In view of a future revision of the family, attention is drawn to the probable value of the male genitalia systematically. I find, for example, that in *Eutrichophilus setosus* and in *E. coëndu* Stobbe (**15**) the male genitalia are of quite the same type. This is described below. Another type, perfectly distinct, is formed by *Trichodectes latus*, *T. crassus*, *T. pinguis*, and probably by others (see p. 271). Still another type may be seen in the male genitalia of *Trichodectes gastrodes* Cummings (**16**, p. 99), *T. mephitidis* Osborn (**17**, p. 242), *T. geomydis* Osborn (**18**, p. 54), and *T. interrupto-fasciatus* Kell. & Ferris (**19**, p. 61), which agree in the fusion of the parameres at their distal ends and in the bifid form of the endomeres (see **16**, text-fig. 4; and **19**, pl. vii. fig. 2, pl. viii. figs. 4 & 6).

*Male Copulatory Apparatus* (text-fig. 17).—*Basal plate*: Broad anteriorly narrowing gradually to the posterior end, where the plate is constricted into a narrow "waist," to which the endomeres and parameres are attached. The lateral margins are narrow, rod-like, the posterior third broader. The anterior part of the plate, as is frequently the case, is thinned out, composed of delicate chitin with an almost invisible anterior margin.

*Parameres*: Of the appendages at the base of the plate, I take the outside ones to be endomeral and the two elongate inner ones parameres. The homologies of the other parts figured I do not indicate, pending further dissections.

Text-figure 17.



*Eutrichophilus setosus.* Male copulatory apparatus. × 182.

*BP.* Basal plate; *E.* endomerial chitinisations; *P.* parameres; *?.* problematical parts.

### *Comparison with the Male Copulatory Apparatus of* E. coëndu *Stobbe.*

This is of exactly the same type. *Basal plate*; Much broader in relation to its length than that of *E. setosus*, and much broader at the base. Between the two lateral margins at the base lies the same little chitinous piece as in the preceding species, only it is larger and stretches right across the plate, almost from one margin to the other, narrowing at each end; in the middle, pointing upwards and backwards from the hind margin, is a small sharp-pointed process. The two inner appendages are narrow, and twice as long as the outer ones. These, probably the endomeres, are very short, broad, stunted pieces, articulating with the basal plate.

### Genus LÆMOBOTHRIUM Nitzsch.

LÆMOBOTHRIUM TITAN Piaget (**2**, p. 578).

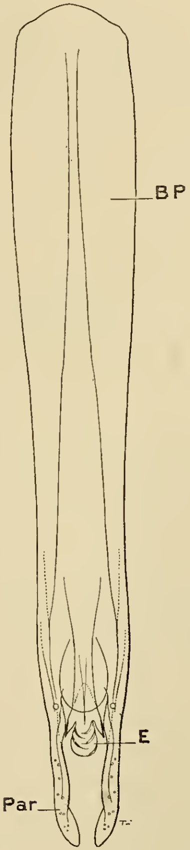
6 ♀♀, 3 larvæ from an Accipitrine bird. Host's name not given.

### Genus GONIOCOTES Burm.

GONIOCOTES MICROTHORAX Nitzsch (**10**, p. 184).

1 ♂, 1 ♀ from the Common Partridge (*Perdix perdix* Linn.).

Text-figure 18.



*Goniocotes gigas.* Male copulatory apparatus. × 87.

*BP.* Basal plate; *E.* endomeral chitinisation; *Par.* paramere.

The parameres possess sensory hairs in large alveoli. Compare with text-fig. 23.

GONIOCOTES VERRUCOSUS Taschenberg (**13**, p. 94).

I have ventured to identify with Taschenberg's species a single male from *Crypturus noctivagus* (Wied). The species was described by Taschenberg from a single male taken on *Crypturus variegatus* (Gmel.).

GONIOCOTES sp.

1 larva from *Querquedula flavirostris* (Vieill.).

GONIOCOTES GIGAS Piaget (**2**, p. 238). (Text-fig. 18.)

1 ♂, 1 ♀, and an immature form from *Crossoptilon mantchuricum* Swinhoe.

The text-figure of the male copulatory apparatus is drawn from a specimen in a tube full of this species, presented to the British Museum by the Hon. N. C. Rothschild.

*Male Copulatory Apparatus.—Basal plate*: Very long and narrow; parallel-sided. Anterior half uniform brown. Posterior half with brown lateral margins and a pale median area. *Parameres*: Relatively short, spear-shaped.

### Genus STRONGYLOCOTES Taschenberg.

STRONGYLOCOTES CONICEPS Tasch. (**13**, p. 63).

1 ♂ from *Crypturus noctivagus* (Wied).

This species is known from a single male specimen taken on *Crypturus variegatus* (Gmel.).

### *Goniodidæ from Tinamous.*

The collection contains Goniodidæ from *Nothoprocta cinerascens* (Burm.), *Rhynchotus rufescens* (Temm.), and *Crypturus noctivagus* (Wied), belonging to four or five different species, but in each instance the material, consisting of but one or two specimens, is insufficient in a confused group such as this to make their determination satisfactory. For the time being, therefore, I am reserving these specimens until the time is ripe for a much-needed revision of Tinamou Goniodidæ.

### Genus GONIODES Nitzsch.

GONIODES COLCHICUS Denny (**21**).

1 ♀ from *Phasianus versicolor* (Vieill.) and 1 imperfect specimen from *P. colchicus*.

GONIODES DISPAR Nitzsch (**10**, p. 193).

1 ♂, 1 ♀ from the Common Partridge (*Perdix perdix* Linn.).

GONIODES MINOR Piaget (**2**, p. 256).

1 ♂, 2 ♀ ♀, and 1 larva from *Leptoptila reichenbachi* Pelzeln.

### Goniodes megaceros Kell. & Paine (**22**).

1 ♂ from *Lophophorus refulgens* Temm.

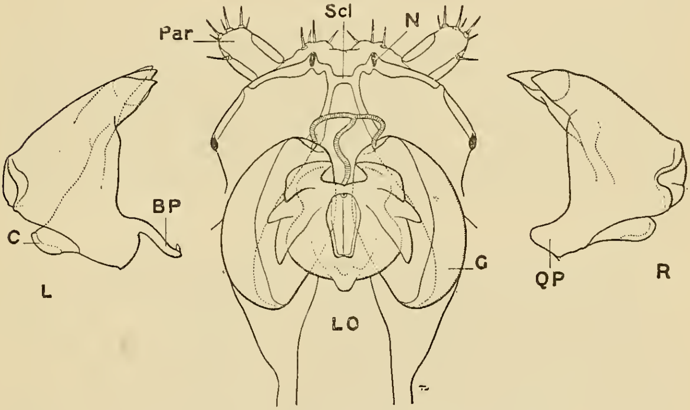
The species is based on a single male from the same host. Concerning the copulatory apparatus, the authors, in passing, note that it is "prominent with heavily chitinised rods reaching to the second abdominal segment." In their figure (pl. xv. fig. 8) the genitalia are shown as seen through the integument, but with the parameres in front and the basal plate behind! The specimen prepared probably had its genitalia exserted and coiled over its back with parameres pointing backwards, and in the course of being mounted the apparatus became pressed down upon the abdomen in the reversed position.

### Goniodes falcicornis Nitzsch (**10**, p. 198). (Text-fig. 19.)

Several specimens from *Pavo cristatus* var. *nigripennis* Sclater.

*Mouth-parts* (text-fig. 19).—*Mandibles*: The *left* (dorsal surface) is roughly of the shape of an equilateral triangle; at the exterior basal angle is a small cup-shaped socket where the mandible articulates with the head; at the inner basal angle is the usual tooth-like process which is here in the form of a long narrow stylet, curved at the base, and carrying at the tip preaxially a small recurved tooth. The apex of the triangle is produced, and carries two distinct cutting-edges with separate tips. On the ventral surface the mandible is more of an isosceles triangle in shape, the base-line being shorter and about midway along its length, running out into a large rounded condyle of dense chitin. In the *right* mandible the basal process as usual is quadrangular, the large

Text-figure 19.



*Goniodes falcicornis*. Mouth-parts. × 113·5.
L. Left mandible. R. Right mandible.

*BP*. Basal process; *C*. condyle; *G*. gland; *LO*. lyriform organ; *N*. chitinous nodule; *Par*. paraglossa; *QP*. quadrangular process; *Scl*. sclerite.

middle condyle is the same as in the right, and the socket at the external angle is somewhat deeper. Two very distinct apices are present, situated laterally one to the other, the longer one separated from the shorter by a considerable space. Ridges in both mandibles absent. *First Maxillæ*: These lobes call for no special mention. *Labium*: "Paraglossæ" as usual; anterior margin is concave in the middle with a small convex swelling on each side carrying four or five spines. On the dorsal surface of the labium, *i. e.* within the oral opening, is visible a sclerite of the same shape and in the same position as that described in *Trichodectes gastrodes* (**16**, p. 99). It consists of a transverse band with two limbs at each extremity, one anterior and one posterior. The posterior one in this case is very long, and runs back on the inside of the under surface of the labium almost as far as the hind end of the "gland" or basal piece. The anterior one is noteworthy, as it runs forward a short way and then near the base of the paraglossa runs into a dark brown chitinous nodule, visible on the other side of the labium. Shipley (**24**) regards this nodule described in *G. tetraonis* as a labial appendage. *Œsophageal sclerite*: The text-figure shows the form of this organ in this species.

*Male Copulatory Apparatus.*—Mjöberg (**4**, p. 249, text-fig. 142) has published a drawing of this apparatus which is so inaccurate as to require, some time in the future, to be carefully refigured. The morphology of the parts is more or less clear, there being basal plate, parameres, endomeres, and penis, but the features which make this relatively enormous apparatus so remarkable are the strange and complex forms which the several parts have assumed.

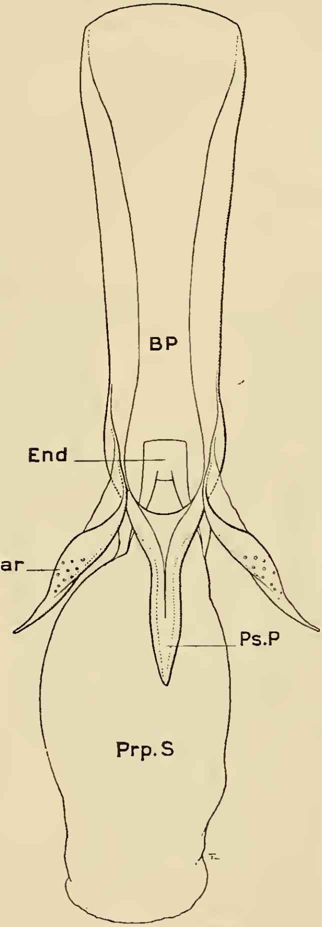
GONIODES BICUSPIDATUS Piaget (**2**, p. 278). (Text-figs. 20–22.)

Several specimens from *Tragopan caboti* (Gould).

A tube of the same species from *Ceriornis satyrus*, presented to the Museum by Lord Rothschild, contained several larvæ of two stages, the description of which is included below.

*Male Copulatory Apparatus* (text-fig. 20).—The following description is drawn up from a specimen preserved *in copula* with the female. The parts, therefore, were exserted and their exact relation easily made out. *Basal plate*: Long and fairly broad. Anterior end thin and colourless. Dark brown marginal bands along posterior half. *Parameres*: Rather like a rabbit's ear in outline. The distal end is produced into a very narrow, slender, needle-like apex. The *sac* is covered with small teeth, especially at the distal end, but I have been able to discover no true penis. At the base of the sac the *endomeral* chitinisations consist of two parts, a dorsal and a ventral. The dorsal is a stout, lanceolate, median piece, quite separate from the sac, and probably functioning as a penis. The ventral is a small, thin, rectangular plate, lying between the two lateral bands at the base of the basal plate, and giving support to the sac. From each of the two anterior lateral angles it sends off a long supporting process down the membranous sac. When functioning, the paramenes stand off at right angles to the sides of the basal plate and serve to anchor the apparatus within the female's genital cavity.

Text-figure 20.

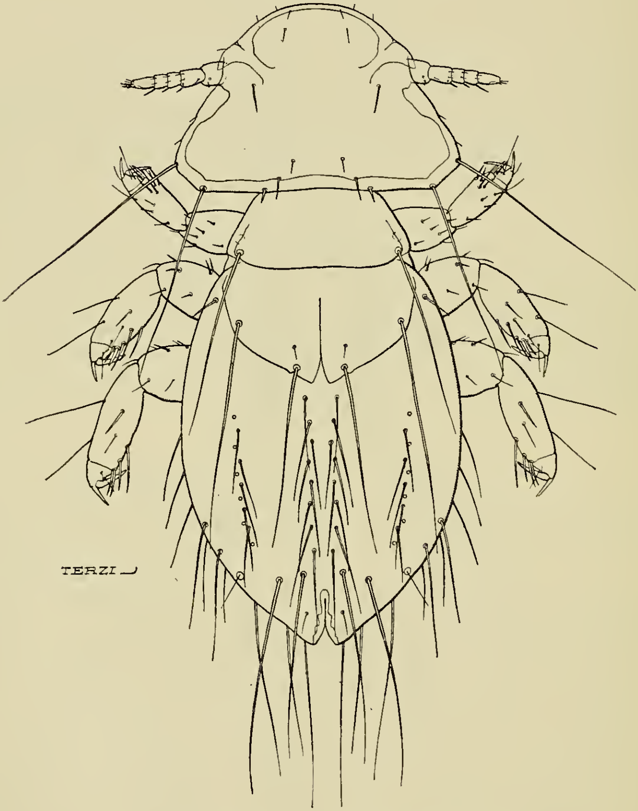


*Goniodes bicuspidatus.* Male copulatory apparatus. × 60.

*BP.* Basal plate; *End.* endomere; *Par.* paramere; *Prp.S.* preputial sac; *Ps.P.* pseudo-penis.

*Larvæ.*—The larvæ, I believe, were all those which, ultimately, with one exception (see text-fig. 22, *a*) would have matured into females, as in all the specimens the head had assumed, even in Stage I., the definitive female form. Both the head and the thorax, not only in form but in chætotaxy, are practically identical with the adult female, even in the earliest stage in the collection, which will probably prove to be Stage I. I have also made one or two dissections of the larval mouth-parts and can discover no characters in which they differ materially from those of the adults. The larval abdomen, however, requires separate treatment.

Text-figure 21.

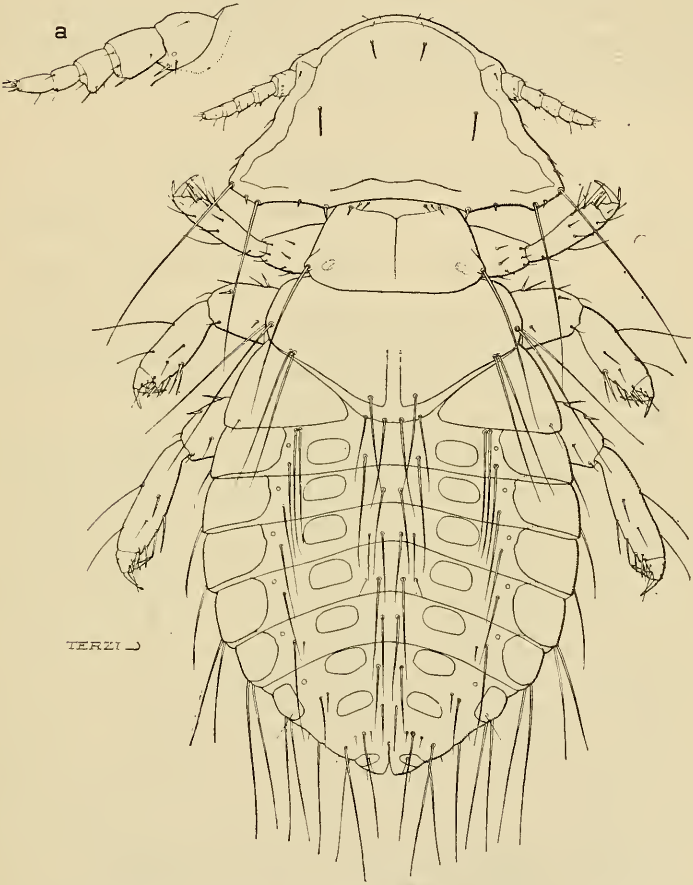


*Goniodes bicuspidatus.* Larva. Stage I. × 49.

*Stage I.* (text-fig. 21). *External Form.—Abdomen*: Small with an even margin, devoid of all sclerites. *Chætotaxy*: The arrangement of bristles cannot be safely described from one specimen, and that given in the figure must be regarded as approximate only. The abdomen bears a great many bristles, all relatively very long and powerful.

*Stage II.* (text-fig. 22). *External Form.—Abdomen*: Pleurites of a simple form developed. As in the adult the pair immediately behind the metanotum are very large and run in over the dorsum a considerable way. But the rest are simple quadrilateral plates lying dorsally on the lateral margin. The small

Text-figure 22.



*Goniodes bicuspidatus.* Larva. Stage II. (or III. ?). × 33.

*a.* Antenna of another larva, probably male, showing a slight enlargement of segment 3.

spiracle lies on the inner margin of each pleurite, about halfway along its length. Tergites are present in the form of circular or oval plates, two on each segment, and each tergite is just on the inside of, but separated by a space from, the pleurite. In the adult this space is filled in, and the tergite and pleurite unite.

*Chætotaxy.—Abdomen*: This differs but little from that of the adult female. But there are apparently some interesting differences from Stage I. (compare the metanotum in text-figs. 21 & 22). There are fewer hairs in the mid-dorsal region of each segment, and the chætotaxy around the end of the abdomen and the genital opening differs considerably, of course, from the adults, in which the sexual organs are matured.

### Genus RHOPALOCERAS Taschenberg.

RHOPALOCERAS STYLIFER Nitzsch (**10**, p. 200). (Text-figs. 23, 24.)

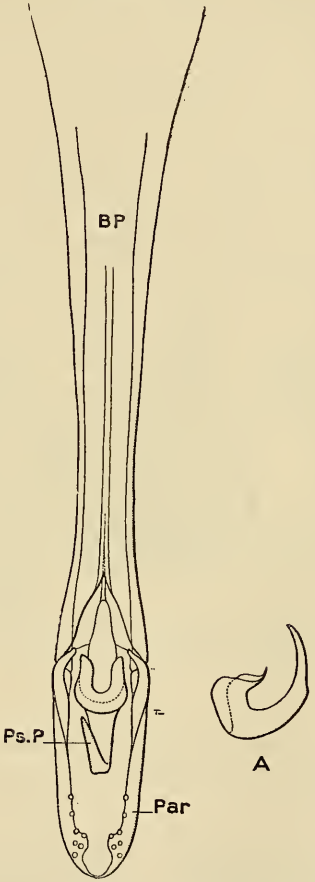
1 ♂. Host not given; probably from *Meleagris gallopavo* Linn.

*Male Copulatory Apparatus* (text-fig. 23).—For the purposes of the following description I have been able to make use of specimens of this common Turkey parasite, kindly placed at my disposal by the Rev. Jas. Waterston, B.Sc.

The apparatus in this remarkable-looking insect presents features of great interest, inasmuch as it is reduced to a very small size (although in no sense atrophied), in correspondence no doubt with the fact that the terminal segments of the abdomen have become modified so as to take part in the function of copulation. Similar adaptation of the end of the abdomen to the function of copulation is not rare in Mallophaga. *Basal plate*: Long and narrow, margins slightly thicker than the median area; the anterior end a little broader and thinner. *Rest of the Apparatus*: This is so highly modified that the attempt here made to bring it into line with the parts in other Mallophaga is only partial and tentative. Parameres as such are absent. Instead, articulating with the basal plate is a small trowel-shaped plate with the concave side uppermost. Along the lateral margins (dorsal surface) of the distal half of this plate there are on each side seven minute directive hairs with large alveoli. Contained within the hollow formed by the trowel-shaped plate, and coiling upwards and backwards so as to resemble a crook, lies the penis (or a pseudo-penis?). This crook-shaped piece at its base is set in a stout horseshoe-shaped piece of dense chitin, the two arms of the horseshoe being directed towards the basal plate. The parts are perhaps a modification of those of *G. gigas* (see text-fig. 18), the parameres having coalesced. (*Cf.* **4**, fig. 143.)

*Terminal Segments of the Abdomen of the Male* (text-fig. 24). *Dorsal surface*: The 7th tergite is a narrow transverse band which, unlike the preceding tergites, runs right across the dorsal surface from side to side. This is succeeded by a large shield-like plate of chitin forming the fused tergites of the 8th and 9th segments. There is a deep median bay in its posterior margin, into which is closely fitted the broad bases of the terminal stylets. *Ventral surface*: The 7th sternite is broad and long and, unlike the preceding sternite, runs right across the sternum from side to side. In front, the anterior part encroaches somewhat upon

Text-figure 23.

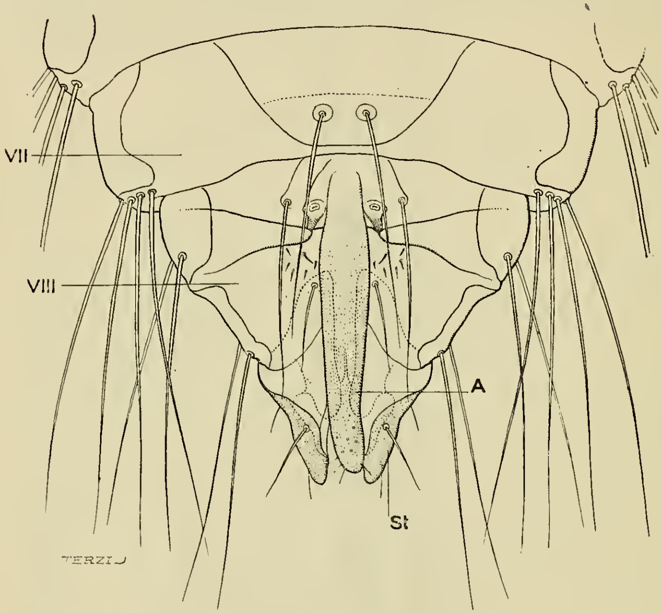


*Rhopaloceras stylifer*. Male copulatory apparatus. × 185.

*BP*. Basal plate; *Par*. paramere (fused); *Ps.P*. pseudo-penis (*A*. side view).

the sternal area of the 6th segment. Immediately in front of the base of the appendage, which is hinged on to the 8th sternite, the 7th shows a noticeable quadrilateral development of its middle part which carries two bristles. The long, narrow, finger-shaped appendage is attached in the mid-line of the 8th and extends to the end of the abdomen, where it curves up between the two terminal stylets, which are excavated somewhat on their inner surfaces to allow the appendage to pass and to project on the dorsal surface. This appendage on its dorsal surface is concave, convex below. The dorsal channel is formed by the bending over of the free lateral margins, which meet in the middle but can be separated by a needle and bent back and flattened out as a plate. At its base the chitin is pinched up to form a hinge. On each side of the middle line the sternite is developed into a triangular piece, with the apex pointing inwards. The 9th and 10th sternites apparently not developed.

Text-figure 24.



*Goniodes stylifer*, ♂. Terminal segments of the abdomen. Ventral view. × 58.

*A.* Appendage; *St.* terminal stylet; *VII.*, *VIII.* segments.

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